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**6. AUTHOR(S)**

Dr Hanna Reisler & Curt Wittig

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

Dept of Chemistry
Univ of Southern California
Los Angeles CA 90089-0482

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110 Duncan Ave Suite B115
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Dr Michael Berman

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**13. ABSTRACT** *(Maximum 200 words)*

Our earlier studies of molecule-surface CID were extended to the case of NO2, which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited NO2. Because the NO2 zeroth order 2B2 excited state is strongly coupled to the 2A1 ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely, NO2 entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal plus translational energy to undergo CID, which was observed for a range of NO2 internal excitations. Unexcited NO2 yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that NO2 decomposes rapidly following impact with the surface, in accord with k(E) measurements that indicate subpicosecond lifetimes for excess energies - 500 cm-1. This was the first demonstration of such an effect ans supports the thesis that NO2 is responsible for the shuttle glow.

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**May 1993 - April 1994**

**PARENT AFOSR AWARD: Grant No. F49620-92-J-0168**

# *GAS-SURFACE INTERACTIONS NEAR DISSOCIATION THRESHOLD*

**Prepared by:** Hanna Reisler and Curt Wittig
Chemistry Department
University of Southern California
Los Angeles, CA 90089-0482

**Submitted to:** Dr. Michael Berman
Program Manager
Directorate of Chemical and Atmospheric Sciences
Air Force Office of Scientific Research
Bolling Air Force Base
Washington, D.C. 20322

**Technical Report:**

Our earlier studies of molecule-surface CID were extended to the case of $NO_2$, which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited $NO_2$. Because the $NO_2$ zeroth order $^2B_2$ excited state is strongly coupled to the $^2A_1$ ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely, $NO_2$ entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal *plus* translational energy to undergo CID, which was observed for a range of $NO_2$ internal excitations. Unexcited $NO_2$ yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that $NO_2$ decomposes rapidly following impact with the surface, in accord with k(E) measurements that indicate subpicosecond lifetimes for excess energies > 500 $cm^{-1}$. This was the first demonstration of such an effect and supports the thesis that $NO_2$ is responsible for the shuttle glow.

In addition, recent FTIR spectroscopy of ClNO adsorbed on MgO(100), suggest that ClNO aggregates on the surface in a way that affects photon-induced processes.

The progress of the students, James Brandon and James Singleton, in their course-work as well as other requirements of the Ph.D. program is satisfactory.

**Evaluation Report**

The parent award number to which the AASERT students are linked is F49620-92-J-0168. The amount of funding of the parent award for the period 12/01/93 - 11/30/94 is $175,000 and one (1) graduate student was supported under the said award prior to and after the AASERT award. The amount of funding under the AASERT program for the period 05/01/92 - 04/30/95 is $94,091 ($31,364 per year) and two (2) graduate students (above-mentioned names) were partially supported under this award for the period 05/01/93 - 04/30/94.

This is to certify that James Brandon and James Singleton are United States citizens. Verification was made through presentation of their birth certificates stating their birthdates and birthplaces, as well as their social security numbers.

A-1